

NAVAL POSTGRADUATE SCHOOL Monterey, California



DoD Inventory Management Cultural Changes and Training in Commercial Practices

by

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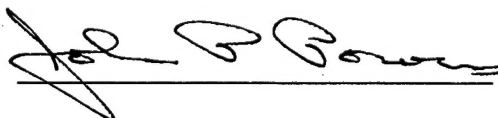
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In this research we investigate the causes of DoD excess inventory, and difficulties in implementing commercial practices for DoD inventory management. Although commercial logistics operations resemble the military's in many ways, simply training in commercial practices without understanding fundamental differences between the commercial operations and military operations will not change DoD inventory management culture. DoD's current mission, organizational structure, evaluation, and reward systems promote excess inventory. Focusing on material availability at any cost without regard for high inventory levels leads to conflicting objectives. DoD must review all the fundamental factors of inefficiency including organizational structure, evaluation and incentive/reward systems. DoD should not expect inventory managers to accomplish these tasks. This problem is a leadership issue. The solution must be a top-down approach.

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THE DOD INVENTORY MANAGEMENT CULTURAL CHANGES AND TRAINING IN COMMERCIAL PRACTICES

I. INTRODUCTION

As the largest single portion of discretionary spending in the federal budget, the Department of Defense (DoD) is a prime target for budget cuts. Perceptions of fraud and waste have put DoD under tight scrutiny, resulting in many Congressional inquiries and General Accounting Office (GAO) audits. Several of these have identified excess inventory as an area needing major improvement (see the list of related GAO reports in the References Section). As reported in the GAO Report GAO/HR-97-5, DoD's inventory was estimated to be \$69.6 billion in 1995. The report also states that about half of the \$69.6 billion inventory is considered excess, beyond what is needed to support war reserve and current operating requirements.

While military inventory management practices have remained largely unchanged, the past thirty years have witnessed a revolution in the way commercial firms manage their inventories. The private sector has completely changed its view of logistics and how logistics contributes to profitability. As a result, businesses have slashed their on-hand inventories, improved their distribution systems, developed long-term relationships with a small number of suppliers who produce top-quality products, and improved their bottom lines.

How can DoD better manage its inventories, get rid of excesses and free up scarce defense dollars for recapitalization and other needs? Can DoD apply the same commercial practices, such as just-in-time (JIT) inventory, direct vendor delivery (DVD), total asset visibility (TAV), and logistics cycle time reduction, that have slashed private sector inventories?

For many years, numerous GAO reports (see the list in the References Section) have pointed out that training in commercial practices would significantly improve DoD inventory management. Although commercial logistics operations resemble the military's in many ways, simply training in commercial practices without understanding fundamental difference between the commercial and the military operations will not change DoD inventory management culture.

In this paper we discuss the causes of DoD excess inventory, and difficulties in implementing commercial practices for DoD inventory management, followed by conclusions and recommendations.

II. CAUSES OF EXCESS INVENTORY?

Each of the services and Defense Logistics Agency (DLA) define excess inventory differently. For example, the Navy definition is any stock that is above the combination of war reserves, safety level, expected demand during administrative and production lead times, economic order quantity (EOQ), and the reorder point, plus eight years of demand at current consumption rates. War reserves are not a significant factor in this model, accounting for less than 1% of Navy inventory (DoD's Supply System Inventory Report as of September 30, 1995).

The DLA definition of excess is any stock that is above six years of demand at current consumption rates. The DLA model does not consider war reserves, safety stock, economic order quantity (EOQ), reorder point, or administrative and production lead times.

Computing a precise dollar value of excess DoD inventory is extraordinarily complex. Besides using different definitions of excess inventory, different accounting systems result in some items being valued at original purchase price, some at current price, and some at scrap value. Many of these items were purchased years ago or are no longer in production, thus assigning a price to them is largely guesswork.

Our research has uncovered a multitude of causes for DoD excess inventory. We first present a list of causes, then discuss each cause with some examples. Some causes are more critical than others, yet most of them do not exist in the commercial sector.

1. Incentives for Item Managers, Supply Personnel and Users
2. Unpredictable Demand and High Stockout Cost
3. Lack of Asset Visibility
4. Government Contracting Regulations
5. Monopsony and Lack of Competition
6. Inexperienced Personnel and High Personnel Turnover and
Multiple Inventory Managers
7. National Stockpile Requirements and Economic Considerations
8. Geographically Dispersed Commitments and Separate Service
Transportation Networks

9. Decrease in Requirements and Base Realignment and Closure (BRAC)
10. Lack of Customer Confidence and Receiving the Wrong Consumable Part
11. Support of Allies
12. Poor Estimates During Initial Procurement Planning
13. Demilitarization Costs

1. Incentives for Item Managers, Supply Personnel and Users

The commercial sector has the goal of satisfying customers by producing and delivering goods that are high quality, low cost, and quickly delivered. Commercial logistics managers are rewarded based on efficiency and response time. Although high inventory levels can improve response time by making sure goods are always available, they are costly and subject to obsolescence and pilferage. In the commercial sector, high levels of inventory are seen as an unnecessary, expensive liability.

In contrast, DoD commanders are evaluated in terms of readiness to perform their operational mission. DoD inventory managers are customarily evaluated in terms of how well they support the operating forces. Within DoD, this is usually expressed in terms of three measures:

1. Supply Material Availability (SMA): the percentage of time a requisition will be filled when it first hits the system. 85 percent is a typical funded SMA goal.
2. Number of Backorders : the total number of line items for which there are requirements, but no inventory in stock in the system. The goal is to minimize this number.
3. Average Customer Wait Time (ACWT) or Supply Response Time (SRT): the number of days it takes for an average requisition to be filled. The goal is to minimize this number.

DoD inventory managers and operating force supply personnel are trained to focus on these criteria, and will use them to express how well they are performing. In fact, all three measures improve when large quantities of material are on hand, which can be seen as insurance against

unforeseen circumstances. Item managers typically perceive that the worst thing they can do short of breaking the law is to run out of stock on an item. Table 1 shows how these measures and some others that are used result in excess inventories, duplicate requisitions and other inefficiencies.

Performance Measure	Resulting Item Manager Behavior
Supply Material Availability (SMA)	Keep higher inventories
Average Customer Wait Time (ACWT)	Cancel documents that cannot be filled quickly
Number of Backorders	Cancel documents that cannot be filled quickly
Number of orders shipped	Split large orders into many small orders Ship small orders first
Pounds of Material Shipped	Ship large or heavy orders first

Table 1. Performance Measures That Have Been Used to Evaluate Inventory Managers and the Resulting Behaviors

Other incentives also contribute to holding excess inventories. When an item is excessed, Navy item managers often hold it on site until the Defense Reutilization and Marketing Office (DRMO, a DLA activity) identifies a buyer, since item managers are assessed a transaction charge for shipping excess material to DRMO of roughly \$33 per line item, regardless of quantity. They are assessed the same transaction cost again when DRMO moves the item out of its warehouse. By holding the item on site, they are only charged once. In contrast to the Navy, DLA item managers do ship excess material to DRMO as they are charged a holding cost for items held in inventory.

Some senior inventory management personnel do have performance measures that reward getting rid of excess inventory. For example, senior DLA inventory managers (GM-13 and above)

are graded on Sales to Inventory Ratio and Percentage of Material Considered Excess in addition to SMA, ACWT and number of backorders. DLA's goal is to maximize the sales to inventory ratio, defined as the total dollar sales from a DLA facility divided by its average inventory. This ratio is maximized by holding a small inventory of high demand items. Excess inventory reduces this ratio by increasing inventory without increasing sales. DLA tries to minimize the percentage of excess material held.

2. Unpredictable Demand and High Stockout Cost

Unlike the commercial sector, DoD inventory requirements are driven by national security commitments. There is no forecasting model that can predict next year's demand for DoD services. The military must be in a constant state of readiness. Many critical components used in DoD weapons systems have lead times of over a year that cannot be significantly reduced, even with additional funding. Additionally, a wartime inventory model is completely different from that of peacetime. As a result, DoD maintains stocks of items it may never use as insurance against the threat of a foreign crisis.

In the commercial sector, the cost of a stockout can be estimated in dollars, derived from a combination of lost revenue, back ordering costs, and lost customers. This is not the case for defense items. Defense forces must be ready to respond on a moment's notice to a crisis anywhere in the world. The cost of running out of stock of an item might be measured in lives, perhaps even thousands of lives. DoD's high stockout cost drives inventory levels of many items higher.

3. Lack of Asset Visibility

Many inventory excesses are due to a lack of total asset visibility. Individual service inventory information systems cannot access information on similar items managed by different services. For example, the Navy cannot read information on the DLA's Standard Automatic Materiel Management System (SAMMS) database, the Army or the Air Force databases. This results in redundancies, where inventories of joint service items are maintained by both services.

For example, 21 percent of the Navy's weapons system support items are multiple use; the corresponding figures are 43 percent for the Army, 34 percent for the Air Force, and 73 percent for

the Marine Corps. It is quite conceivable that a service may buy an item which another service is holding in a warehouse unused (Department of Defense Joint Staff, 1996, p. 5). For example, the GAO found 69 modular radio transmitters owned by the Army and classified as excess stored at Warner Robbins Air Force Base. These are dual use USA/USAF radio components, valued at approximately \$16,000. The Army had not made these items available, and the USAF had not attempted to obtain disposition authority. (GAO/NSIAD-95-64, 1995, p. 9)

Current inventory management information systems do not track high cost repairable components through the complete repair cycle in a real-time manner or track the actual status of material being contracted for. The lack of asset visibility is one of the major causes of long turn-around times that not only increase unnecessary pipeline inventory, but deteriorate combat readiness.

The services are making a significant effort to improve JTAV. Without JTAV, *you cannot manage what you do not know you have*. The Army is the lead service for JTAV, whose goal is to provide interoperability among currently stove-piped inventory systems and to facilitate consolidation of stock points. When fully implemented, JTAV will provide asset visibility *from the factory to the foxhole*. Inventory managers can then reduce total inventory and cost, while improving response time. JTAV will improve customer confidence in the supply system. Operational units will ultimately be able to electronically track requisitions all the way to the factory, making their supply personnel less likely to hoard items or order multiple times for the same requirement.

4. Government Contracting Regulations

Government contracting is quite different from commercial sector contracting and contributes to higher DoD inventory levels. Government contracting does not exist merely to buy goods for the government. It also tries to ensure equity in contract awards, and to promote socio-economic goals. Unfortunately, the objectives of government contracting frequently conflict with the concept of efficiency, and preclude the adoption of commercial logistics practices. Under the Competition In Contracting Act (CICA) of 1984 and the Federal Acquisition Regulations (FAR), government contracting operates on the premise of *full and open competition*. This essentially means that every contract is open to any firm that desires to bid on it. While competition in itself is desirable in

producing better quality at a lower price, the government approach to competition can be deleterious. Since most government contracts are awarded individually, the length of time required to complete them does not decrease over time. This process is quite long, as it involves determining the requirement, setting specifications, writing the contract, soliciting and evaluating bids, awarding the contract, and dealing with protests. Despite recent reform under the Federal Acquisition Streamlining Act (FASA) of 1994, the tremendous volume of paperwork and regulations involved in government contracting are significant barriers to reducing cycle time. Consequently, inventory levels are higher to compensate for longer replenishment times.

The concept of *full and open competition* on every bid does not give adequate weight to a contractor's past performance in technical merit, reliability, and ability to deliver on schedule. As long as a firm can barely meet the minimum requirements to produce an item, it cannot legally be prohibited from bidding. A firm's past willingness to cooperate in resolving disputes and ambiguities is rarely considered as an evaluation factor (DSMC, 1991, p. 3-4). The government cannot boycott uncooperative companies or place most of its business with more responsive firms. As a consequence of these factors, there is no incentive for a vendor to provide the best product or service. Although the government has a concept called *best value* which states that factors other than price should be considered in making a source selection, many government contract awards are still price-driven. This is *penny wise* and *pound foolish*, because added reliability or quality may well be worth a slightly higher price. FASA emphasized best value as an attempt to put common sense back into the procurement process. The full impact of FASA has yet to be felt.

Government regulations dictate that a firm must offer its *best customer price* to the government. This indirectly reduces quality by limiting competition. The problem with this idea is that firms give their best customer price based on a mutual relationship of long-term commitment and cooperation. The government demands to be treated as a best customer without being willing to behave as one (DSMC, 1991, p. 5-4).

Delays in payment and litigation are also an obstacle. The government not only demands the lowest price and resultant lowest profit margin, it is also frequently the last customer to pay, and the most likely to initiate litigation. Given this situation, it is understandable why many firms refuse

to bid on government contracts, even if they could supply better quality products at lower prices than the eventual contract winners. (DSMC, 1991, p. 4-4)

Another way that the government reduces competition is by insisting on far more information than the commercial sector. The government generally requires more documentation, such as user and maintenance manuals and schematic drawing packages, than is normally produced with commercial products. Generating these documents is usually a distraction for the supplier, since people are diverted from their usual work activities to develop them. Additionally, they are reluctant to provide detailed technical data about their products for fear of revealing competitively advantageous information. Unless a firm is in business to produce technical documents, requesting them in addition to what is normally provided with a product in different form or format discourages vendors from selling their products to the government. (DSMC, 1991, pp. 5-3, 4)

The government will frequently ask for data rights detailed enough to enable it to competitively rebid subsequent contracts. Companies with specialized techniques and processes will often refuse to bid on government contracts, since they would be giving away trade secrets. The government also insists on cost and pricing data for contracts over \$500,000. This practice has no counterpart in the commercial sector, and in fact this information is often considered proprietary. (DSMC, 1991, p. 5-4) In addition, the large volume of paperwork involved in government contracting often discourages vendors from bidding.

Some of the social goals of government contracting result in awarding contracts on the basis of race, gender, or company size rather than on quality or past performance. This can result in lower quality firms and products being selected. It can also result in higher prices, or in purchases from a company in financial trouble that may not be in business when spare parts or technical assistance are needed.

In summary, the limited profit, late payment, lack of commitment for future business, requests for proprietary information, and award of contracts based on criteria other than price and quality all inhibit bidders. By reducing the number of competitors, the government indirectly reduces the quality of items it purchases. The lack of follow-on business means there will be high variability between an item bought on one contract and the same item bought on a subsequent contract. If a delivered item is substandard, it may be months before a new contract is let to procure

the same item. Consequently, the DoD needs higher inventory levels to compensate for the unpredictable quality of items it purchases.

5. Monopsony and Lack of Competition

Monopsony is an economic term meaning *one customer*. For example, DoD is the only purchaser for many weapons systems. This is desirable for many defense items, since the exclusive use of the latest weapons and their support systems provide the U.S. with a competitive edge on the battlefield. Under monopsony, an item's manufacturer is only going to make the item once or infrequently. It only makes sense for the manufacturer to want to produce a large lot size and then use its production resources on other items. This increases DoD's inventory, since it must buy and hold more inventory than it could purchase if the item were commercially available. While monopsony is unavoidable for weapons systems, it is not necessary for many secondary items such as spare parts, clothing, and medical supplies. However, government regulations and specifications have driven many secondary items into this situation.

Most of the DoD activities are not allowed to use supply systems other than DoD's. It eliminates competition, and the inventory managers do not have motivation to take a risk to make drastic changes. They are busy to take care of their day-to-day business, and the government rules and regulations discourage them to take initiatives in implementing commercial practices that might result in significant improvement in the supply system.

6. Inexperienced Personnel and High Personnel Turnover and Multiple Inventory Managers

In the commercial sector, inventory management personnel typically remain in the same job for several years, and often stay in the same location for their entire career. A similar situation exists for some DoD civilian inventory managers. However, this is not true in the operating forces. Personnel turnover in most operating units is over 25 percent per year. Promotion is rapid compared to the private sector. Personnel rapidly rotate through different tasks in order to acquire a variety of skills. Consequently, military supply personnel do not develop in-depth inventory management experience.

7. National Stockpile Requirements and Economic Considerations

Many DoD excess inventories are held due to National Stockpile requirements. DoD warehouses cannot sell or dispose of these items by law. In addition, selling some of these items has the potential to devastate commercial and even world markets that would be flooded by the abundant supplies in DoD stockpiles. Consequently, the military maintains its excess stocks of these commodities. For example, Table 2 shows the amount of various items in National Stockpile storage at Defense Depot Letterkenny, Pennsylvania, that do not have much economic values.

Commodity	Tons in Storage	Sq Footage Occupied
Asbestos	550	42,966
Chromite Refractory Ore	30,564	158,000
Lead	663	213,000
Manganese Ore	72,360	316,000
Nickel	5,947	71,000
Talc	470	7,161
Tannin	13,301	296,060
Zinc	8,518	71,000

Table 2. Items in National Stockpile Storage at Defense Depot Letterkenny, PA

8. Geographically Dispersed Commitments and Separate Service Transportation Networks

United States international commitments require DoD operating forces to be deployed worldwide. It is simply not possible for all users to be geographically close to their suppliers. Also, the government's insistence on full and open competition means that any firm in the country, regardless of location, can bid on contracts. These factors increase inventory requirements to compensate for longer replenishment times.

All four armed services and DLA maintain their own transportation networks. These separate networks cannot see each other's assets or cargoes. Consequently, economies of scale and centralized control are not realized. This arrangement negates the advantages that could be gained by maintaining a common logistical system under one command. Inventories must be higher because the separate networks are not as efficient as a consolidated system would be.

9. Decrease in Requirements and Base Realignment and Closure (BRAC)

As requirements for an item decrease and there is enough material on hand to support the older, higher requirements, excess inventory is created. A decrease in requirements can result from the weapons system being phased out, reliability improvements, a change in operational use, reduction in repair cycle time, reduction in administrative or production lead time, or a reduction in war reserve requirements. Examples include:

- 1) As Oliver Hazard Perry (FFG-7) class frigates were sold or transferred to the USNR, demand for ship-specific items of the USN decreased.
- 2) Strengthening the corners of ALE-39 Chaff/IR buckets increased their Mean Time Between Maintenance (MTBM), and reduced requirements.
- 3) As some EA-6B aircraft transition from carrier-based to land-based USAF support, demand for some items should decrease, because the planes will experience less corrosion when they are removed from a salt-water environment, and aircraft components will experience fewer failures since they will not undergo the shock of catapult launches or arrested landings.

The overall downsizing of DoD over the past several years has significantly decreased demand for many items, as force structures contract and bases are closed or realigned under the Base Realignment And Closure (BRAC) process. In addition, closing a base almost always results in identifying excess inventory that is not on accountability records. Items from activities that were closed or realigned under BRAC do not stratify into excess for two years. This allows some of these stocks to be consumed, and provides continuity in the excess management process. Absence of this

provision would cause most stocks from *BRAC'ed* activities to immediately go excess, since closing a base increases the supply of material while decreasing the customer base.

10. Lack of Customer Confidence and Receiving the Wrong Consumable Part

Operating forces often do not have confidence in the ability of the supply system to support them, so they hoard items, and deliberately order more than they need. This stems from a philosophy of *readiness at any cost*. During Desert Shield, when the Army's 24th Infantry Division deployed to Saudi Arabia on three weeks notice, it ordered items two and three times for each requirement, because they did not have confidence in the system. Since the 24th was in a combat zone and had top priority on requisitions, this double and triple-ordering not only created excess material in the 24th, it hampered the readiness of subsequently deployed units by taking needed items out of the supply system. Units deploying after the 24th followed suit in multiple ordering. As a result, approximately 40,000 Sealand containers were sent to the Arabian Gulf during Desert Shield/ Storm. About 22,000 of these were never opened.

A unit may order the wrong part because of a keypunch error, or poor manuals or technical assistance. Also, supply activity database may contain inaccurate stock numbers, which would result in the wrong part being sent to the unit. If the item was ordered correctly, the ordering activity can submit a Report Of Discrepancy (ROD) and receive the correct item at no additional charge. If the item was ordered incorrectly, there is currently no practical mechanism for an operational unit to recoup money it has spent on this part.

11. Support of Allies

Support of our allies often forces DoD to hold items that would otherwise be excess. These may be from Foreign Military Sales (FMS) contracts or from regional agreements. A Navy FMS example is the A-4 aircraft that has been sold to many nations. The U.S. must retain spare parts to meet demand from these aircraft, even though the A-4 is no longer in U.S. service. An example of a regional agreement forcing the U.S. to hold excess inventories is 155 mm howitzer ammunition for the Republic of Korea (ROK, commonly called South Korea). Although the ROK manufactures

this ammunition, they do not store it in sufficient quantities should war break out on the Korean peninsula. Therefore, the U.S. Army maintains a stockpile for use by the ROK Army, since ROK forces hold 3/4 of the front line.

12. Poor Estimates During Initial Procurement Planning

When new weapons systems are fielded, initial estimates of which components will break and how often come from the contractor in an Interim Support List (ISL). Unnecessary items on the ISL contribute to excess DoD inventories. There is no incentive for the contractor to limit the size of the ISL, since they profit from each item on the list. For example, the B-2 bomber ISL contained 6,000 line items. After two years of operational use, only 400 of the 6,000 had been used at all.

13. Demilitarization Costs

Old military equipment must be demilitarized before it can be either sold or disposed. The funding comes out of Operations and Maintenance (O & M) dollars, the same dollars the services use to pay for current operations. In this time of tight funding, there is simply not enough priority to pay for demilitarization of old equipment when the services need the money for today's operations.

An example is old radar components at Defense Depot Letterkenny, PA. The exact frequencies these radars generate are classified, so the item must be carefully dismantled in such a way that it cannot be reconstructed. Another example at Letterkenny is 3,032 backpack-style riot control dispensers. This model is no longer in use, but it cannot be simply thrown away because of the potential for terrorist action. This model can be converted to a garden sprayer and then sold on the open market, however, the O & M dollars needed to do that are not available.

III. COMMERCIAL INVENTORY MANAGEMENT PRACTICES

The commercial sector is fiercely competitive. Companies that do not provide top-quality products and service may quickly find themselves out of business. This fierce competition ensures that companies keep up to date in capability and remain competitive on price. The logistics function in many companies is evaluated by its contribution to the firm's profitability. This leads many companies to seek ways to reduce inventory without compromising customer service, since excess inventory is expensive to maintain and subject to obsolescence and pilferage. This section discusses some of the characteristics of modern commercial inventory management. It is obvious that only some of the concepts and techniques commercial firms use to manage their inventories are suitable for adoption by DoD.

1. Just-In-Time (JIT)

Just-in-time systems minimize a commercial firms' investment in inventory by relying on suppliers to only provide materials right before they are needed. The advantages of JIT are:

- 1) *Elimination of Unnecessary Activities.* For instance, receiving activity and incoming inspection activity are unnecessary under just-in-time.
- 2) *Elimination of In-Plant Inventory.* Virtually no raw material inventory is necessary if materials that meet quality standards are delivered where and when they are needed.
- 3) *Elimination of In-Transit Inventory.* Modern purchasing departments address in-transit inventory reduction by encouraging suppliers to locate near the plant and support rapid transportation of purchases.
- 4) *Quality and Reliability Improvement.* Reducing the number of suppliers and increasing long-term commitments to suppliers tends to improve supplier quality and reliability. (Heizer and Render, 1996)

2. Outsourcing

Outsourcing is the practice of contracting out non-strategic functions. This allows a company to concentrate on its core competencies and let other firms handle ancillary functions. Outsourcing often enables a company to maximize its return on investment by better serving its customers, and can serve as a barrier to entry for potential competitors. In the past, accounting, payroll, and temporary office help were often outsourced. Now logistics is increasingly treated the same way, as companies realize that their expertise lies elsewhere.

The practice of outsourcing may go so far as to create a *virtual company*, where even the employees are temporary hires. Virtual companies have fluid, moving organizational boundaries, and rely on a variety of supplier relationships to provide services on demand (Heizer and Render, 1996, p. 534). Nike, Inc. an example of a company that out sources all of its production.

Nike Inc. is the largest supplier of athletic shoes in the world. Yet it out sources 100% of its shoe production and manufactures only key technical components of its *Nike Air System*. Nike creates maximum value by concentrating on preproduction (research and development) and postproduction activities (marketing, distribution, and sales). (Mintzberg and Quinn, 1996, p. 64)

3. Stable Demand and Low Stock Out Cost

Commercial logistics practices assumes a stable, predictable demand pattern, which enable both supplier and purchaser to effectively plan for the future to maximize productivity. Consequently, frequent deliveries in small lot sizes are possible. This minimizes the in-plant inventory, and reduces stockage costs.

The potential penalty of stockout in the commercial sector tends to be low. An example is a clothing retailer, who might convince a customer to purchase another item or to backorder the desired good, knowing that the logistics system can quickly respond. Substitutability of products helps, because a company could use another supplier if one was out of stock.

However, for some industries in the commercial sector a high stockout cost hampers implementation of commercial logistics. For example, an airliner that is not mission capable can

cost tens of thousands of dollars per hour in lost revenue, so quick response is a must. Here is an example of Boeing and General Electric (GE) inventory practices for jet engines. GE uses normal current commercial logistics, holding minimal stock and turning over its inventory ten times per year. Boeing uses a more traditional inventory system with high quantities of material on hand, and an inventory turnover of .5 per year. In 1992, Boeing's SMA was a consistent 99 percent, with delivery occurring in under 24 hours anywhere in the world. GE's SMA ranged from 80-85 percent. Customers could not afford the low SMA that GE's commercial logistics practices provided, so they have increasingly turned to Boeing. Since 1992, GE has substantially increased its inventory in an effort to boost its SMA and keep customers.

4. Cycle Time Compression

Cycle time compression is a reduction in the time between when the customer places an order and when the customer receives the order. There are several separate transactions involved in this process, including order placement and transmittal, order processing, payment, picking the item in the warehouse, packing it for shipping, transporting it to its destination, and tracking its status. Automating, consolidating, or running these elements in parallel can dramatically reduce overall cycle time. Johnson & Johnson (J & J) greatly improved its cycle time as follows (Andel, 1994, pp. 95-102):

J & J uses Manugistics, an integrated set of supply chain management applications, to help it meet the replenishment demands of all its customers. Using information from Electronic Data Interchange (EDI) transmissions, this software links the Support Center with J & J's customers and distribution centers. The system is tied directly to the company's order management system -- which includes order processing, transportation load building, and sales reporting systems. Information from these systems is fed downstream to each of the separate operating units to provide decision support throughout the organization.

By linking all of these functions electronically, J & J has slashed its cycle time, while at the same time improving accuracy. A relationship known as *Little's Law* (Little, 1961) shows that reductions

in cycle time will result in equivalent reductions in terms of percentage in pipeline inventories (i.e., cycle time and pipeline inventory have linear relationship). For example, a company that can reduce the maintenance cycle time by 10% can reduce the pipeline inventory by 10%.

5. Long-Term Relationships with a Small Number of Suppliers

Developing long-term, close relationships with good suppliers is essential to success. Reduced inventory means more frequent deliveries and a heavy reliance on both the supplier and the distribution system. Leading edge companies evaluate suppliers based on quality and their demonstrated ability to meet delivery schedules.

Open, two-way communication is critical to developing the mutual trust and respect needed in a long term relationship. Buyers frequently share production or operations schedules with a supplier, so the supplier can anticipate buyer needs. Sharing information reduces variability and response time. Some companies go further, integrating suppliers directly into their logistics system. Support can include training, engineering and production assistance, and even work spaces inside the buyer's facilities. Buyers and vendors consider themselves as colleagues working together. This kind of arrangement enables both firms to maximize profit. Contracting costs are virtually eliminated, and administrative and inventory costs are sharply reduced.

According to Heizer and Render (1996), Xerox has cut its number of suppliers by 90 percent, Motorola by 70 percent, General Motors by 45 percent, Ford by 44 percent, and Texas Instruments by 36 percent. This is a difficult concept for DoD to adopt. The Competition in Contracting Act (CICA) requirements for full and open competition are an obstacle to the government's ability to establish and maintain commercial-like relationships with a small number of suppliers. Most contracts awards are competed individually with no commitments for future follow-on business (DSMC, 1991, p. 3-4). There is often no continuity from one contract to the next, even for the same item.

6. High Quality Products

Quality is the ability to consistently meet or exceed customer expectations. Top quality is a necessity to realize the benefits of commercial logistics practices. Commercial firms employ a variety of techniques to improve quality, including statistical process control to reduce variation, continuous process improvement, and Total Quality Management (TQM). Better quality means less inventory and a better, easier-to-employ JIT system. Often the purpose of keeping inventory is to protect against poor production performance resulting from unreliable quality. If consistent quality exists, JIT allows us to reduce all the costs associated with inventory.

DoD is somewhat hampered in its ability to purchase higher quality items if an acceptable item or service is available for less cost. DoD contracting initiatives such as *best value* contracting and being able to take contractor past performance into account on future procurement are examples of DoD applying a high quality product philosophy.

7. Integrated Information Systems

Information technology is a key part of successful commercial inventory management. Companies must know exactly what inventory they have, where it is, and if it is in transit, where it is going and when it is going to get there. Leading edge firms focus on integration across supply channels to build EDI links with partners, suppliers, customers, and carriers. Information systems reduce the need for inventory and eliminate redundancy in procurement.

8. Centralized Shipping Near to Corporate Headquarters

To receive the most benefit from a logistics system, it should be centralized near the strategic apex of the company, so the firm can integrate logistics into the strategic planning process. Centralization enables a company to maintain tight control while consolidating shipments and lowering costs. In 1993, the University of Maryland surveyed 20 companies seeking best logistics practices and found that all of them had centralized their strategic logistics management function in proximity to the corporate center. This pattern contributed to company-wide planning and

organizational activities. All cited increased control, improved efficiencies, and lowered costs as the primary motivations behind their centralization philosophy.

9. Direct Vendor Delivery

Direct delivery is another form of a *pull* inventory system. A manufacturer ships products directly to a retailer's store, instead of to the retailer's warehouse. The advantage is that the retailer has eliminated inventory holding costs on that item, and only calls for the item to be delivered to the store when needed. A disadvantage is that shipping costs will probably increase, since there will usually be more Less Than Truckload (LTL) shipments.

IV. CONCLUSIONS AND RECOMMENDATIONS

The following general conclusions can be drawn from the information presented in the previous sections.

1. Training in Commercial Logistics Practices Is Not the Answer to DoD Inventory Management Problems.

Training in commercial logistics practices alone will not change DoD inventory management culture. Inventory management culture is too complex to be changed by simply training in commercial logistics. To be effective, it must be coupled with changes in other organizational design factors such as reward systems and management control systems. Training is only one of many inputs to organizational behavior. Trying to alter a culture by changing only one of these factors is usually a wasted effort.

Most of the causes of excess inventory are unrelated to training. Issues such as a lack of asset visibility, lack of customer confidence, support of allies, demilitarization, BRAC, and economic considerations have no direct connection to the training of inventory managers. A training program in commercial logistics practices, no matter how well constructed, would have little impact on these causes of excess inventory, primarily those dealing with *uncertainty*. However, educating inventory managers to understand these causes is important for the long-term. At the operational level, supply personnel often lack in-depth knowledge of logistics and supply principles. More training/education could alleviate some of the excess inventory caused by hoarding or multiple ordering.

Several other causes of excess might be affected by training/education, but not necessarily training in commercial logistics practices. The consequences of a decrease in requirements for an item might be partially averted by training the weapons system program office and inventory control point to understand each other's priorities and capabilities. Excess caused by receiving the wrong consumable part can be reduced with better on-the-job training of supply personnel in the fleet. Excess caused by poor estimates of support required for initial procurement can be alleviated with some of the initiatives such as making the contractor responsible for all parts support for the first

several years of a weapons system introduction. This would of course need to be balanced against the national security risk involved in carrying a reduced inventory of spares for a first-line weapons system.

The contracting community may benefit from training in commercial logistics practices that have potential to reduce excess inventory. Problems resulting from government contracting regulations are largely self-inflicted, thus the government has the ability to change its policies to reduce the generation and retention of excess inventory. The Federal Acquisition Streamlining Act (FASA) of 1994 reduced some of the burdensome requirements of government contracting, making it easier to buy quality products and develop long-term relationships. Prime Vendor and Direct Vendor Delivery are two initiatives currently underway that can reduce inventory.

2. Current DoD Inventory Incentives Promote Organizational Effectiveness Over System Effectiveness.

Current DoD performance measures tend to promote high levels of inventory and reflect the traditional emphasis on maximum organizational effectiveness. DoD's prime objective has always been to maintain combat readiness. Operating forces often do not have confidence in the ability of the supply system to support them, so they hoard items, and deliberately order more than they need. The evaluation and incentive/reward systems designed under the concept of *readiness at any cost* discourage commanding officers and inventory managers to be efficient by keeping low inventory levels. They simply do not have strong motivation to reduce inventory level, at the risk of stockout.

3. Many Commercial Logistics Practices May Be Inappropriate for the DoD.

Because of the tremendous differences between the DoD and the private sector as discussed in the previous sections, many commercial practices just will not work in the DoD without understanding the *DoD-unique* management systems. Factors such as unstable demand, huge stockout cost, and geographic dispersion preclude the use of many logistics practices that have proven so successful in the commercial sector. Many causes of excess inventory are beyond the ability of DoD to control. Many of these factors cannot be changed, since they are inherent to being

a military entity of a worldwide superpower. For those it can control, DoD is making good efforts to improve its systems. Joint Total Asset Visibility (JTAV), Direct Vendor Delivery (DVD), and contracts that make contractors responsible for the first several years of weapons system parts support are examples of current initiatives to lower inventories.

RECOMMENDATIONS

The following general recommendations will further reduce DoD inventories:

1. Cycle Time Reduction and Modeling & Simulation (M&S)

The ultimate goal of DoD inventory management is to maintain the highest level of military readiness. The readiness, or operational availability (A_o) of a weapon system is defined as,

$$A_o = \frac{\text{uptime}}{\text{uptime} + \text{downtime}} = \frac{MTBM}{MTBM + MDT}$$

where *MTBM* stands for the mean time between maintenance, and *MDT*, the mean down time. *MDT* includes repair time, and administrative/logistics delay times. Thus the operational availability is the fraction of time the weapon system is up or *mission capable*. The operational availability can be improved by increasing *MTBM* (i.e., higher reliability) and/or decreasing *MDT* (i.e., faster turn-around time). Thus the two key issues to improve weapon systems readiness are **reliability/quality improvement** and **cycle-time reduction**. Using Little's formula (Little, 1961), it is obvious that cycle time reduction results in pipeline inventory reduction. Cycle time reduction in the DoD logistics channel (military depots, intermediate-level maintenance, inventory control points, supply centers, etc.) reduces the number of weapons systems and components in the repair pipeline, thus more weapon systems are available at the fleets/fields, which is translated to not only higher readiness, but also savings in inventory cost.

Modeling and Simulation (M&S) applications to military depots and inventory control points can provide insights into improving logistics cycle times significantly. These efforts in cycle time reduction will bring in not only inventory reduction but customer confidence in the system, thus

will help change management culture. Our follow-up research will concentrate on these M&S applications DoD logistics systems to improve inventory management.

2. Better Performance Measures and Incentives

DoD's current mission, organizational structure, and incentive/reward systems all promote behaviors that encourage excess inventory. Focusing on material availability *at any cost* without regard for high inventory levels leads to ambiguous objectives (local versus global effectiveness). DoD must review all the factors including organization structure, evaluation and incentive/reward systems, and take drastic initiatives that will lead to system improvement.

3. Joint Total Asset Visibility (JTAV)

DoD is on the right track with many initiatives in JTAV, yet DoD should expedite current initiatives to provide total asset visibility throughout the DoD supply system. Systems such as JTAV are essential to restoring customer confidence and improving inventory management efficiency. It is impossible to effectively manage inventory without knowing exactly which items are held and where they are stored. JTAV is the enabler to improving customer confidence in the supply system's ability to support deployed forces.

4. Streamlining Contracting Regulations

This cause of excess inventories is largely self-inflicted. The government has the ability to change its contracting regulations and policies to reduce the generation and retention of excess inventory. The Federal Acquisition Streamlining Act (FASA) of 1994 reduced some of the burdensome requirements of government contracting, making it easier to buy quality products and develop long-term relationships by considering past contractor performance. Prime Vendor and Direct Vendor Delivery are two more examples of contracting initiatives currently underway that can reduce inventory.

5. Standardization of the Definition of the Definition of Excess Inventory

All four armed services and DLA use a different definition of excess inventory. The Navy definition is a protection level plus eight years consumption at current rates. The Army uses a protection level plus one economic order quantity (EOQ). DLA uses six years consumption at current rates with no protection levels. The Air Force and Marine Corps definitions are different from all of the above.

In addition to differing on the number of items considered excess, the services also differ on the valuation of these items. Sometimes a service uses the current purchase price, sometimes the original purchase price, and at other times the salvage value. Standardizing the definition of excess and its method of valuation would enable consistent measurement of total DoD excess inventory, and provide a benchmark for future improvements.

6. Better Coordination Between Program Managers and Inventory Managers

Better coordination between the weapons systems program managers and inventory managers might avoid the generation of some excess inventories. For example, it is important that program managers keep item managers informed immediately of design changes that might affect current procurement. Also, as program offices usually know the very latest information concerning when and the rate at which a weapons system will be phased out, getting this information to item managers quickly might reduce or avert procurement actions. If program offices know of reliability improvements that should reduce demand, inventory managers should be informed. By working together, these two groups can eliminate the deleterious impact their actions sometimes have upon each other.

7. Greater Reliance on Contractor Support, Privatization, and Outsourcing

Excess caused by poor estimates of support required for initial procurement can be alleviated by making the contractor responsible for all parts support for the first several years after a weapons

system introduction. This decision to rely on the contractor must take into account the national security risk involved in depending on someone else to support a DoD weapons system.

Privatization and outsourcing of certain activities are viable options that will lead to competition and improve efficiency. However careful cost-benefit analyses are necessary since privatization and outsourcing may change infrastructure of DoD logistics system.

8. Congressional Review of the National Stockpile

The National Stockpile was created years ago to ensure the self-sufficiency of the U.S. in wartime. Since that time, warfare has changed radically and the U.S. is now dependent on truly global trade to support its interests. Meanwhile, the National Stockpile has remained largely unchanged. It holds some items that are no longer critical to national security, while there may be other items not currently held that should be. A comprehensive review by Congress is in order.

CONCLUDING REMARKS

While DoD inventory and logistics management practices have remained largely unchanged, the commercial sector has completely changed its view of logistics and how logistics contributes to profitability. As a result, businesses have slashed their on-hand inventories, improved their distribution systems, and achieved significant cost savings.

Although commercial logistics operations resemble the military's in many ways, simply training in commercial practices without understanding fundamental differences between the commercial operations and military operations will not change DoD inventory management culture. DoD's current mission, organizational structure, evaluation, and reward systems promote excess inventory. Focusing on material availability *at any cost* without regard for high inventory levels leads to ambiguous and conflicting objectives. DoD must review all the fundamental factors of inefficiency including organizational structure, evaluation, and incentive/reward systems, and take drastic but innovative initiatives that will lead to system improvements. DoD should not expect inventory managers to accomplish these tasks. Many DoD rules and regulations discourage inventory managers to conduct such tasks. The problem is a leadership issue, and the solution must be a top-down approach.

RELATED GOVERNMENT ACCOUNTING OFFICE REPORTS

Defense Inventory Management (GAO/HR-97-5, Feb. 1997)

Defense Supply: Inventories Contain Nonessential and Excessive Insurance Stocks (GAO/NSIAD-95-142, August 1995)

Best Practices Methodology: A New Approach for Improving Government Operations (GAO/NSIAD-95-154, May 1995)

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